Relicts of Archean sediment in the present Earth mantle

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Oceanic island basalts (OIB) are isotopically diverse. While a consensus has emerged on the origin of HIMU- and EM2-type basalts from sources containing, respectively, recycled oceanic crust and recycled terrigeneous sediment, the origin of EM1-type basalts, best represented by Pitcairn volcanism, remains debated.

The geochemical signature of EM1 lavas is extreme, with high $^{208}Pb/^{204}Pb$ at low $^{206}Pb/^{204}Pb$ and is usually attributed to recycled material, although the nature of this material is unclear: both Proterozoic pelagic sediment (1, 2) and delaminated subcontinental lithospheric mantle or lower continental crust (3, 4) have been proposed.

Here we report *in-situ* sulphur isotope signatures measured on both sulphide inclusions and within the matrix of Pitcairn Seamount basalts. We find unambiguous mass-independent fractionation (S-MIF), with $\Delta^{33}S$ ranging from +0.1 to -0.8 with most data below 0. As S-MIF was generated exclusively prior to 2.45 Ga, it sets a time constrain for the origin of the EM1 source. A Monte Carlo refinement based on simulation of Pb isotopic evolution constrains the recycling age to 2.5-2.6 Ga and provides tight estimates of the U/Pb and Th/Pb ratios (6.3-6.4 and 6.3-6.7). Curvature of isotopic mixing arrays in Sr-Nd-Hf-Pb space suggests the Archean material was poor in trace elements similar to Archean sediment.

This demonstrates that material from Archean Earth´s surface cycled into the mantle and remained stored for billions of years before returning to the surface eons later.

(1)Woodhead & McCulloch EPSL (1989); (2)Eisele et al., EPSL (2002); (3)McKenzie & O'Nions Nature (1983); (4)Willbold & Stracke Chemical Geology (2010).